# NAVAIR Corrosion Overview

**February 2009**

**Frederick Lancaster – NAVAIR Materials Engineering Corrosion & Wear Branch**

# Report Documentation Page

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13. SUPPLEMENTARY NOTES
**2009 U.S. Army Corrosion Summit, 3-5 Feb, Clearwater Beach, FL**

14. ABSTRACT

15. SUBJECT TERMS

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT | b. ABSTRACT | c. THIS PAGE | | | |
| **unclassified** | **unclassified** | **unclassified** | **Same as Report (SAR)** | **25** | |

# MATERIALS ENGINEERING
## SERVING NAVAL AVIATION ENTERPRISE NEEDS

### A FULL SPECTRUM APPROACH - S&T, ACQUISITION AND SUSTAINMENT TECHNOLOGIES FULLY INTEGRATED FOR ALL AEROSPACE SYSTEMS:

- AIR VEHICLES
- PROPULSION
- WEAPON SYSTEMS
- AVIONICS & SENSORS
- AIRCRAFT LAUNCH & RECOVERY EQUIPMENT
- SUPPORT EQUIPMENT

***MATERIALS S & T***

- 6.1 - 6.4
- SBIR and ILIR
- Manufacturing Technology
- Environmental Programs
- Technology Transfer
  - Metals and Ceramics
  - Propulsion Materials
  - Corrosion Technology
    - Materials Protection
  - Advanced Polymers and Composites
  - NDI
  - Functional materials

***ACQUISITION SUPPORT/ RISK ASSESSMENT***

- Requirements Definition
- Source Selection
- Design Reviews (PDR/CDR..)
- Materials & Process Specifications/CDRLs
- Design Allowables
- Performance Monitor
- M&P Certification
- Flight Clearance
- Technology Transition
- Repair Development/ Analysis

***IN-SERVICE ENGINEERING/PRODUCTION SUPPORT***

- FRC/ISSC Engineering Support
- Corrosion Prevention & Control
- HAZMAT Minimization / Environmental Compliance
- Aircraft and Engine Maintenance/ Repair/Life Extension Technology
- Engineering Investigations Failure Analysis
- Mishap Investigation
- Aging Aircraft Initiatives
- GS and T/M/S Manuals
- Fleet Bulletins & Inspections


FLEET
OPNAV
NATEC
Group
Integration
Solutions
Depots NAWCs NAVAIR
SPRAYER
Mildew Remover Kit
NAVGUARD
TYPE II
NAVGUARD
TYPE III

# NAVAIR Materials Engineering

## Materials Engineering Division

- Metals & Ceramics Branch
- Industrial / Operational Chemicals Branch
- Nondestructive Inspection Branch
- Polymers & Composites Branch
- Analytical Chemistry & Testing Branch
- Corrosion & Wear Branch

# AMCOM-NAVAIR Corrosion Partnership

*Working together to Solve Common Corrosion Issues*

Mg Components

Shrink Wrap

Mildew

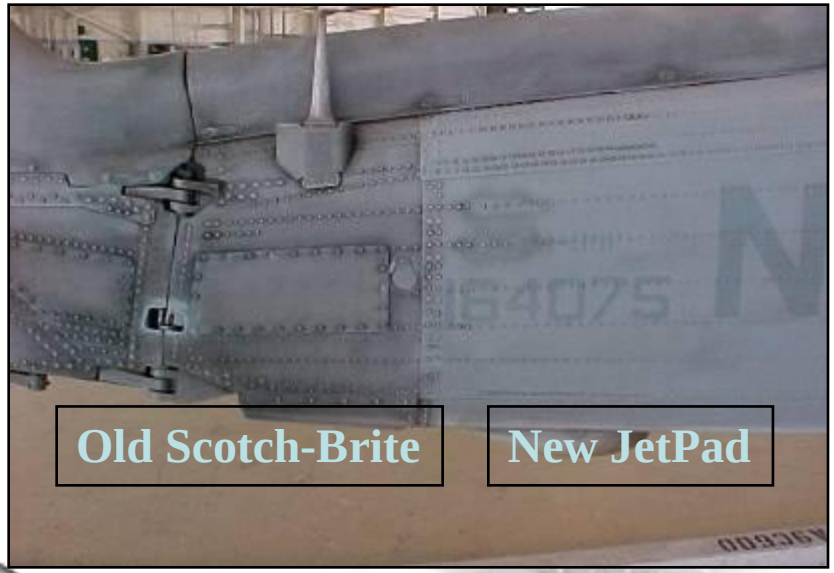
OIF/OEF Helicopters

Connectors

# Technology Transition with the Army

***TARR Radome Boot Remover***

***Wash Pads***




***CPC's – (eg fluid film)***

***Cleaners***

# Corrosion-Inhibited Mildew Remover


- Joint NAVAIR & AMCOM assessment of reformulated Mildew Remover
  - Meets critical characteristics specified in MIL-PRF-85570 and ADS-61A-PRF cleaning specs
  - Effectively removes mildew without corrosion risk of bleach
- U.S. Patent applications filed for compositions & kit
- Composition and kit licensed to commercial supplier
- NAVAIR & AMCOM authorized in 2005
- Implementation pending current FIFRA registration and NSN assignment
- Initerim Kits delivered to Fleet and to Army Units

***Mildew Growth Inside T-39 Aircraft Before Cleaning***

***Cleaning Mildew Growth by Spraying Mildew Remover***

# Long-Lived CPC's


**DESCRIPTION:**

Field validation of improved MIL-PRF-81309 CPC

- Validate performance on multiple platforms
  - Navy, Marines, & Army
- Qualify products to MIL-PRF-81309
- Evaluate performance
  - General use & electrical/avionics applications
- Leveraged with NAVAIR AERMIP program

**APPLICATION:**

- Aviation weapon systems, support equipment and avionics

**HIGHLIGHTS:**

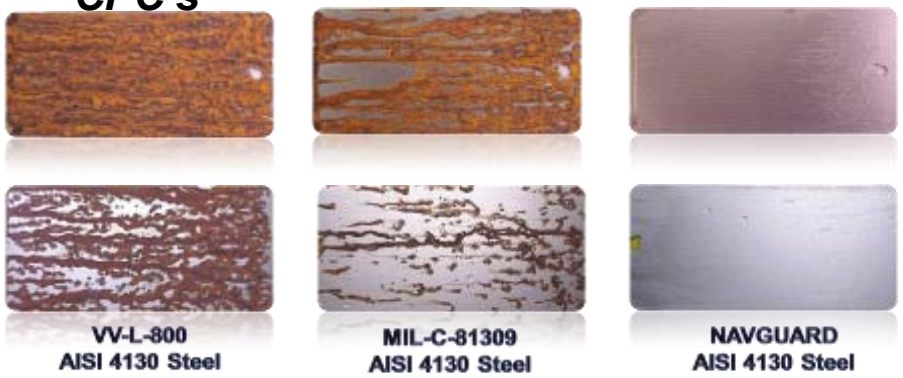
- F/A-18 dem/val underway
  - CSFWL reports excellent performance
- Commercial product being validated against NAVAIR control formula.
- Two licensed products being tested against Type II & Type III

**DEMONSTRATION:**

Field validation – completed 24 months on aircraft

- Report in DRAFT
  - Navy: 17 F/A-18's, 5 EA-6B's, 4 H-46's
  - Army: 1 H-60
  - USMC: 8 EFV's

- ***Develop new spec for long lived CPC's***



# Improved Gaskets

## Before deployment…

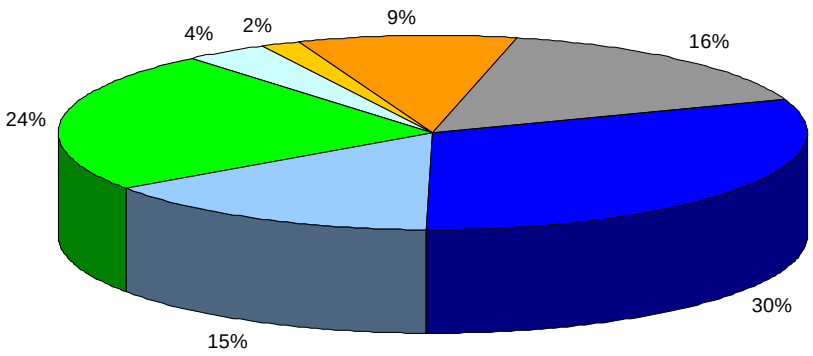
HH-60H Lower UHF/VHF/TACAN Antenna

## …after (no degradation with use of gasket)

## DESCRIPTION

- AvDEC Gaskets for aircraft:
  - Conductive for antenna, static wick and other electrical applications
  - Non-conductive for floorboards
  - Reduced or eliminated com “gripes” and failures during mission
- Estimated ROI: 2.1 (recently re-validated by 4.2 cost analysis on EA-6B and H-60 fleet implementation
  - Type II savings: Time on Wing
    - H-60: now 364 FH (48% improvement)
    - EA-6B: now 449 FH (43% improvement)

AvDEC Conductive Gasket



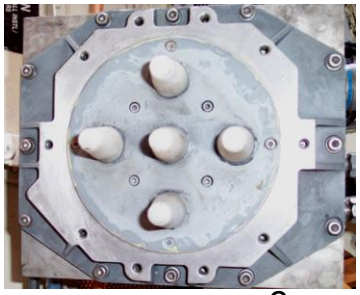

***Before Gasket***

- ***Time to remove antenna: 45 minutes***
- ***Condition: Moderate to severe corrosion on antenna base and aircraft skin.***
- ***Antenna replacement: Average 2.5 per deployment per squadron (i.e. BUNO 164239)***

## F/A-18 Integrated Antenna Cost: $143K

After Gasket

- Time to remove antenna: 4 minutes
- Condition: No corrosion on aircraft skin or antenna.



# Aviation Sheltering

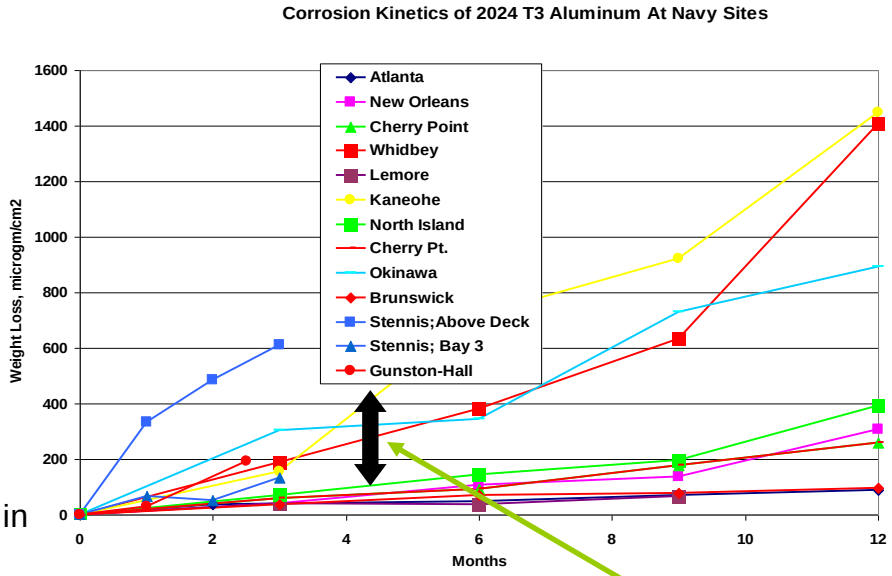
**F/A-18 shelters at China Lake, CA**

Installed corrosivity sensors at China Lake to prove concept for Navy and study shelter effect on corrosion in desert environment

Funding: OSD Corrosion IPT and DLA Reliability Program

- Purchase and install shelters at Whidbey Island and Oceana (EOY 2006)
- Monitor performance of aircraft under shelters compared to control aircraft
- Install corrosivity sensors under shelter and next to shelter, collect data and compare results to aircraft

**T-45 shelters at NAS Meridian**




- Evaluation of impact on aircraft corrosion (and other maintenance) planned for 2006-2008:
  - EA-6B at NAS Whidbey, WA (Installed waivers in place)
  - T-45 at NAS Kingsville & NAS Meridian
  - F/A-18 at NAS Oceana, VA (Planned)
  - NAS Patuxent River FA-18G
- Assess aircraft performance compared to sensor data

**Sheltering showing up to 5-fold reduction in corrosivity in carrier environment and similar attenuation at Tyndall AFB, FL**

# Pre Coated Fasteners

- **Objectives**
  - Dem/Val field performance of a pre-coated/self-sealing fastener technology on Navy/USMC aircraft in operating environments and compare to existing practices
- **Problem**
  - Military standards require permanently installed fasteners to be treated with a corrosion-inhibiting, “wet” sealant prior to installation to meet the stringent corrosion performance required by the military aerospace operational environment.
  - The process is expensive, time consuming, subject to technician error, and requires the use of an environmentally hazardous sealant.

**Candidate Coatings**

- 14 Candidate Coatings screened down to two.
  - Pre-applied Sealant w/ sizecoat
  - Magnesium rich primer

A B C D

***A. Test Plan***

***B. Technical Qualification***

- Laboratory Screening Testing

***C. Technical Validation***

- Field Testing (on aircraft)/Mechanical Test

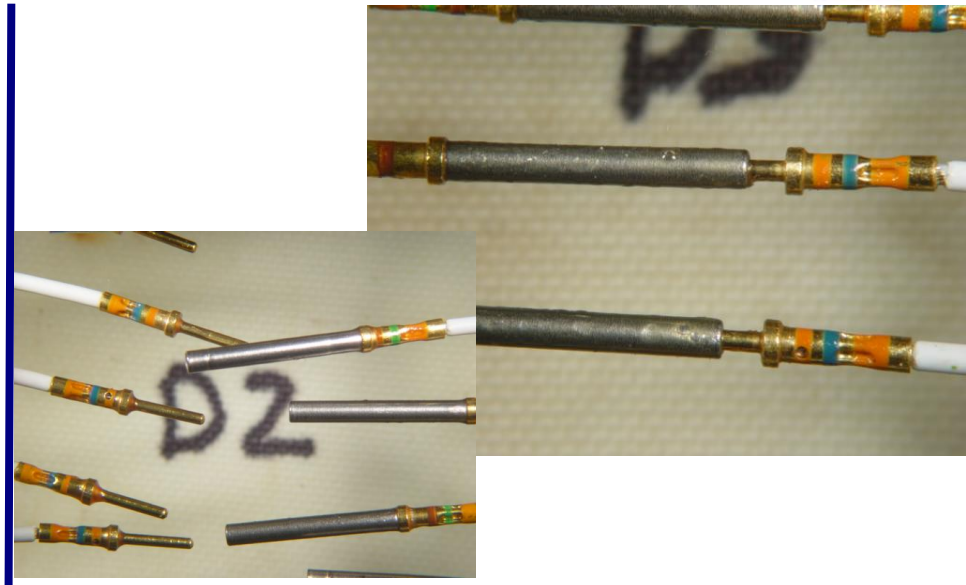
***D. Tech Transfer***

- Assign NSN
- Add to manuals

# MIL-L-87177 Assessment

## Background

- Several studies to evaluate the ability of CPCs to reduce/eliminate corrosion failures.
- Some CPCs more effective than others on component types tested.
- Some CPCs promoted corrosion.
- Unable to control the material meeting older specification.
- A new CPC and specification were developed to better control materials.
- AF and NAVAIR mandates that CPCs be applied to all areas of aircraft.
- NAVAIR request to evaluate new CPC for use on aircraft wiring systems.




## Project Schedule

| | CY 2006 | | | | | | | CY 2007 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Project Approved/Funded | <<<Nov 2005 | | | | | | | | | | | | | | | | | | |
| Contract Awards Phase I, II, IIa | | | | | | | | | | | | | | | | | | | |
| Phase I | <<Complete | | | | | | | | | | | | | | | | | | |
| Phase II | <<Complete | | | | | | | | | | | | | | | | | | |
| Phase IIa | | | Δ | | | | | | | | | | | | | | | | |
| Design and Assemble Fixtures | <<Complete | | | | | | | | | | | | | | | | | | |
| Testing | | | | | | | | | | | | | | | | | | | |
| Group A | | | | | | | | | | | | | | | | | | | |
| Group B | | | | | | | | | | | | | | | | | | | |
| Group C | | | | | | | | | | | | | | | | | | | |
| Group D | | | | | | | | | | | | | | | | | | | |
| Group E | | Complete | | | | | | | | | | | | | | | | | |
| Group F | | Complete | | | | | | | | | | | | | | | | | |
| Group G | | Complete | | | | | | | | | | | | | | | | | |
| Data Analysis and Reporting | | | | | | | | | | | | | | | | | | | |

## Impact to Fleet/Issues

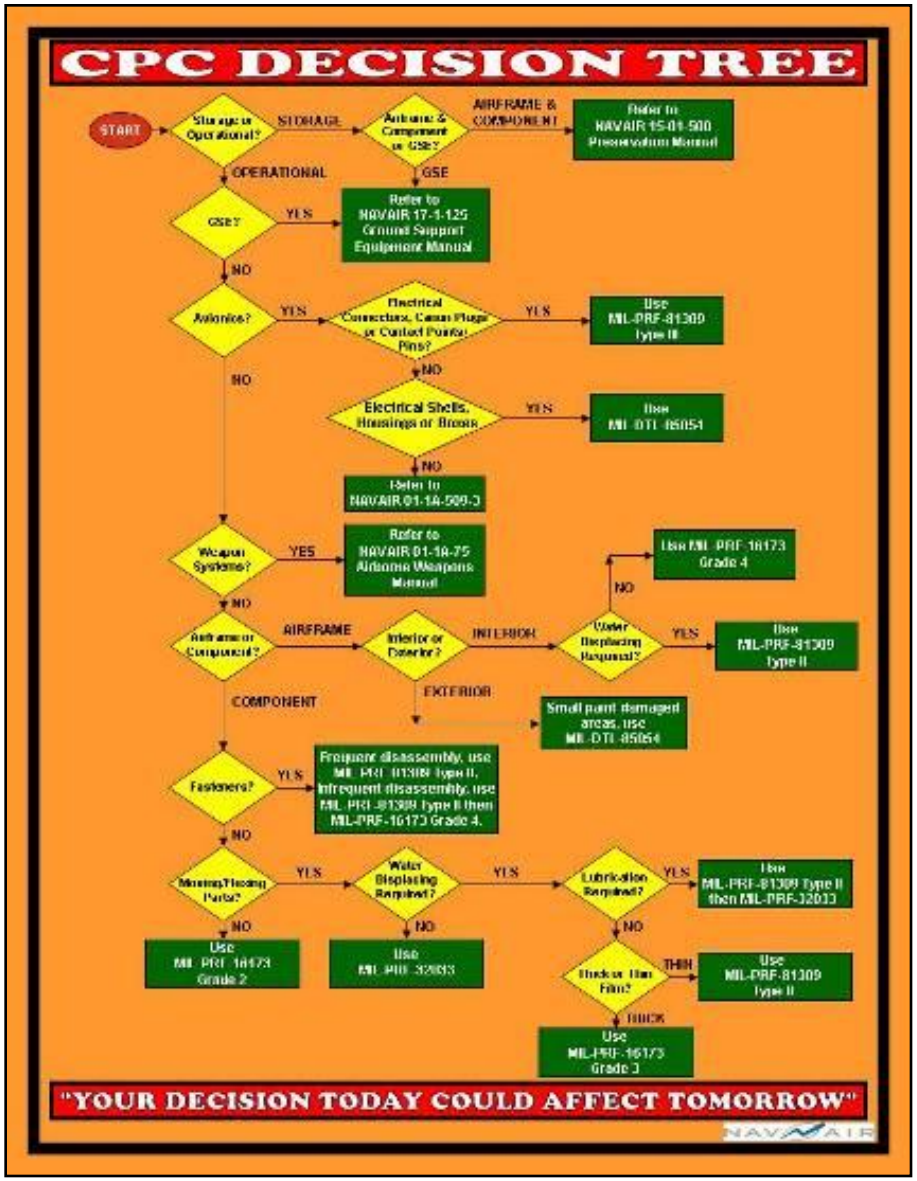
Designed to determine interaction between CPCs and wiring component materials.

- Materials degradation (hardness, swelling, electrical properties)
- Corrosion growth (visual, electrical resistance, functionality, maintenance)

**STATUS:**

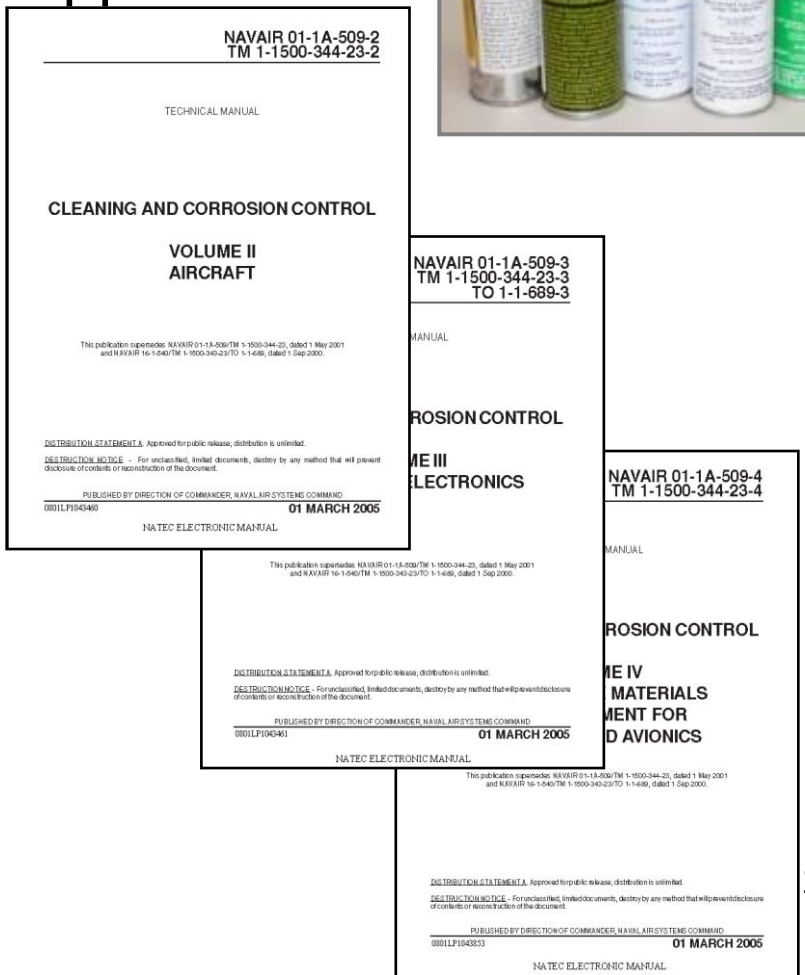
- Testing Complete – final report and incorporation into maintenance documents

# Information Transition




Many Products…

Multiple Applications…



# H-60 Aluminum Gearbox

**DESCRIPTION:**

Prototype new casting process for gearbox manufacturing using aluminum alloys

- New Casting Process - Alcoa
- Working with US Army and Sikorsky Aircraft
- Aluminum offers **significant** corrosion benefits over magnesium
- Potential to reduce or eliminate weight debit with aluminum components

**APPLICATION:**

- H-60 and other rotary wing gearbox assemblies

**HIGHLIGHTS:**

- **Funds received – working contract vehicle through Army H-60 program office for SAC partnership**
- Weight debits from aluminum castings not as large as previously reported
- Aluminum protective coatings weigh much less than resins used for magnesium

**COST IMPACT:**

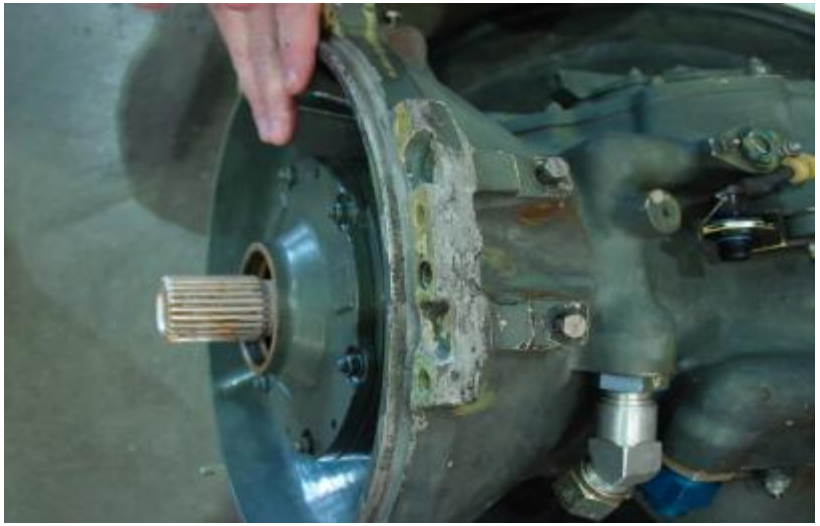
- H-60 main gearbox: $291K
- H-60 tail gearbox: $93.4K

**LABOR IMPACT:**

- H-60 main gearbox: 223 man hours
- H-60 tail gearbox: 57 man hours

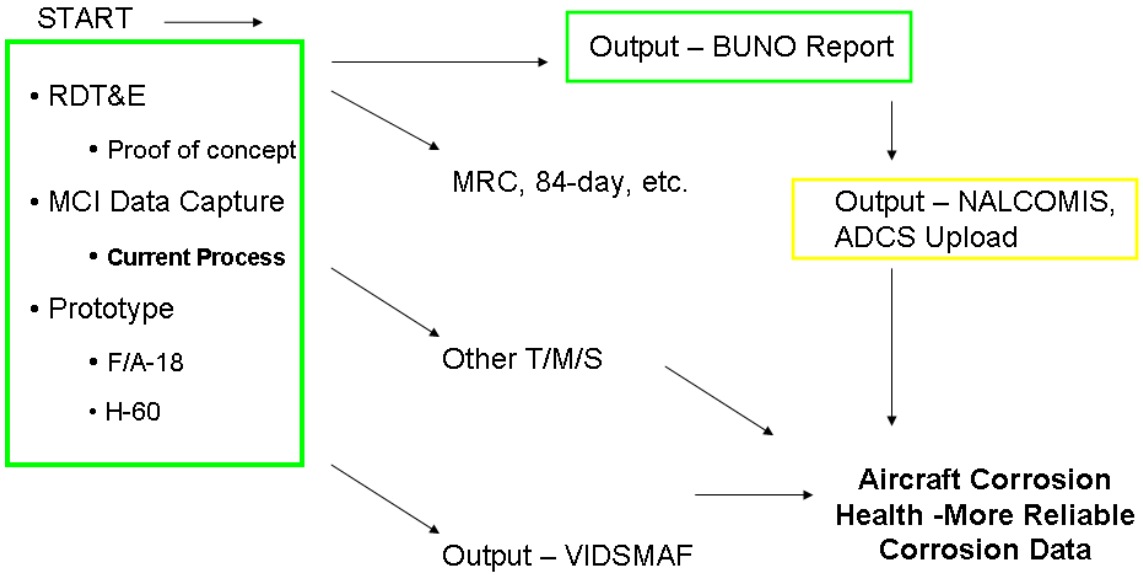
**Annual:**

- Corrosion Scrap Rate – H-60 TGB 27/yr
- Cost – 1 TGB – $94,400 & 57 MHrs
  - $99,530 parts and labor
- Total Annual Expense – $2,687,310*****



# PEDS Inspection Tool

- PEDS – Personal Electronic Device
- O-level inspection & data capture tool
- Demonstration & Validation Project
  - Tool functionality collaboratively built with fleet



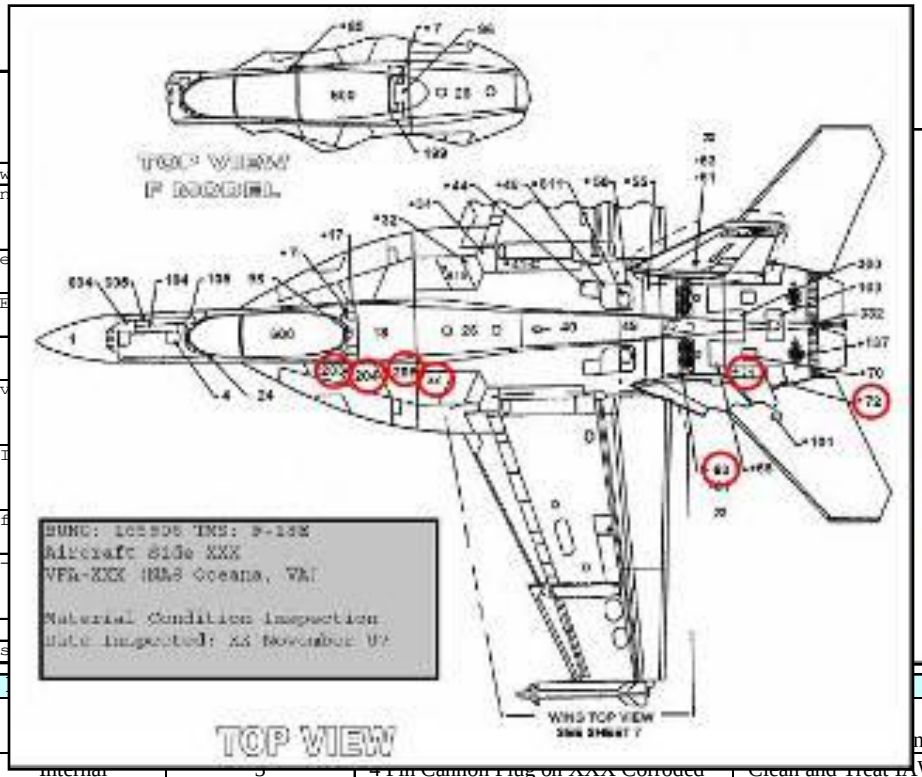

•Phase I – Initial focus on MCIVisual reference tool, MRC's, 509

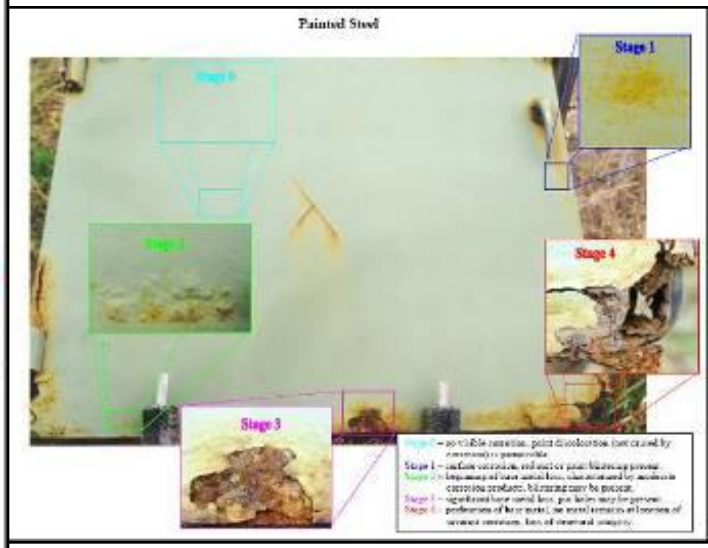
•Electronic data capture, WUC's embedded behind interface

•Report format output/VIDSMAF

# PEDS/MCI

| Task ID | Task |
|---|---|
| 1 | Initial Mtg w |
| 2 | Prototype Win |
| 2.1 | MCI/Depot Spe |
| 2.2 | Conduct MCI/E |
| 2.3 | Develop JQR |
| 2.4 | Develop MCI v |
| 2.5 | Develop MCI I |
| 3 | Provide ROM f integration |
| 4 | TypeWing out- |
| 5 | Update brief |
| 6 | MCI/EE Propos |

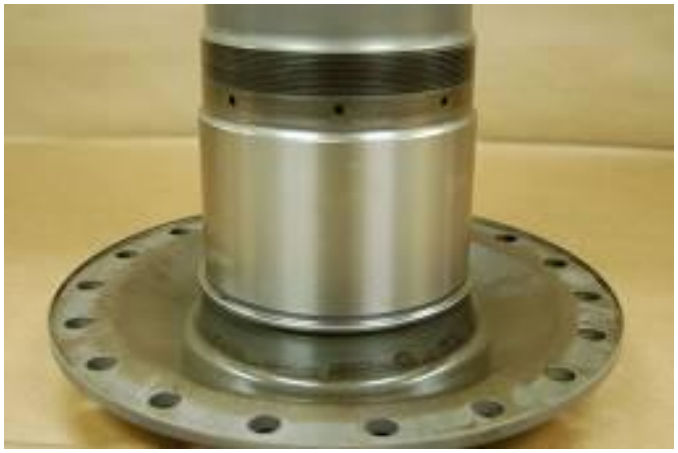



| Location | | | | Action | NLT |
|---|---|---|---|---|---|
| 203L | | | | n and Treat as Req | 84 Day |
| 203L | Internal | 3 | 4 Pin Cannon Plug on XXX Corroded | Clean and Treat IAW NA01-1A-509 | Immediately |
| 203L | External | NFC | Working Rivet | Remove and replace | 84-Day |
| 204L | Internal | 1 | 3 Pin Cannon Plug on XXX needs CPC | Apply Corr Preventative Compound ASAP | Prior to Closure |
| 204L | External | NFC | Safety Wire lossose | Remove and reinstall | Prior to Closure |
| 205L | Internal | 2 | Fastners and Fastner Holes Corroded | R&R Fastners Remove Corr Clean and Treat Fastner Holes as Req | 84 Day |
| 205L | External | 1 | FIP Seal Torn and Missing Pieces | Clean and Treat Area Replace FIP IAW Applicable TM | Immediately |
| 22L | Internal | FC | MLG Door Delaminated | Remove and repair per SRM | Immediately |
| 22L | External | 2 | Panel LE Inbd Corner has Surface Corrosion | Remove Corr Clean and Treat as Req | 84 Day |
| 63L | Internal | 4 | Fwd Bulkhead Inboard Frame Exfoliation | Beyond capability IAW SRM request E&E for FRC Repair | Immediately |
| | Total Score | 1 FC/2 NFC/14 | | | |

# Pulsed Waterjet Decoating

- Pulse Water Jet Stripping of Chrome Plating and HVOF Coatings from Jet Engine Components for NAVAL Aircraft Applications
  - Ultrasonic pulse added to waterjet stream
  - Resonant frequency matched to substrate for coating removal
- Validate the Pulse Water Jet process for stripping chrome plating and HVOF coating from engine alloys without damaging the base metal.
- Strip chrome plated and HVOF coated parts to verify capability on actual engine components.

# Meeting the needs of the fleet
# Environmental issues in Southeast Asia

- Based upon feedback from Navy, Marine, Air Force & Army aviation units deployed to Southeast Asia.
- Main driver is the lack of available clean water for aviation corrosion maintenance.
- Qualified products not available.

# Qualification of Ready To Use (RTU) MIL-PRF-85570 Ty II Cleaners

## Description

- Evaluate currently qualified MIL-PRF-85570 Ty II cleaners in a pre-diluted form and qualify for use. Revise 01-1A-509 and MIL-PRF-85570 specification to include new class
- Benefits: Prevents the use of unauthorized / unqualified products which pose health, safety and aircraft corrosion problems.
- Satisfy fleet need for aircraft spot cleaner as a replacement for high aromatic solvents

## Status

- 4 QPL products currently identified and testing in work (5th to be tested)
  - •Cleaning Efficiency
  - •Hydrogen Embrittlement
  - •Corrosion Testing
  - •Storage Stability (1 & 2 year extended)
  - •Pump Bottles, 5 gal pail, 55 gal drum


+


=


Melamine Wash Pad plus RTU Cleaner yields exceptional results from a water based product.

# Qualification of MIL-PRF-85570 Type I Aerosol and Pre-Moistened Wipes

## Description

- **Evaluate currently qualified MIL-PRF-85570 Ty I products in an aerosol version and pre-moistened wipe form.**
- **Benefits:** Will be a direct replacement for the high solvent unauthorized MIL-C-43616 aerosol.
- Fulfill the need for acceptable aircraft spot cleaners

## Status

- Received 2 candidate products (2 aerosol & 2 wipes) for in-house for testing. Wipe prototype field **tested at Oceana with positive fleet feedback**
- Received second generation prototype wipes & aerosol cans, tested at **Andrews AFB-VAQ 209 with positive feedback**
  - 1:1 dilution on wipes seems optimal

**MIL-PRF-85570 Type I Pre-saturated Wipes – Foil Pouch & Plastic Tub**


**Unauthorized MIL-C-43616 aerosol (L) with candidate MIL-PRF-85570 TY I Aerosols (R)**

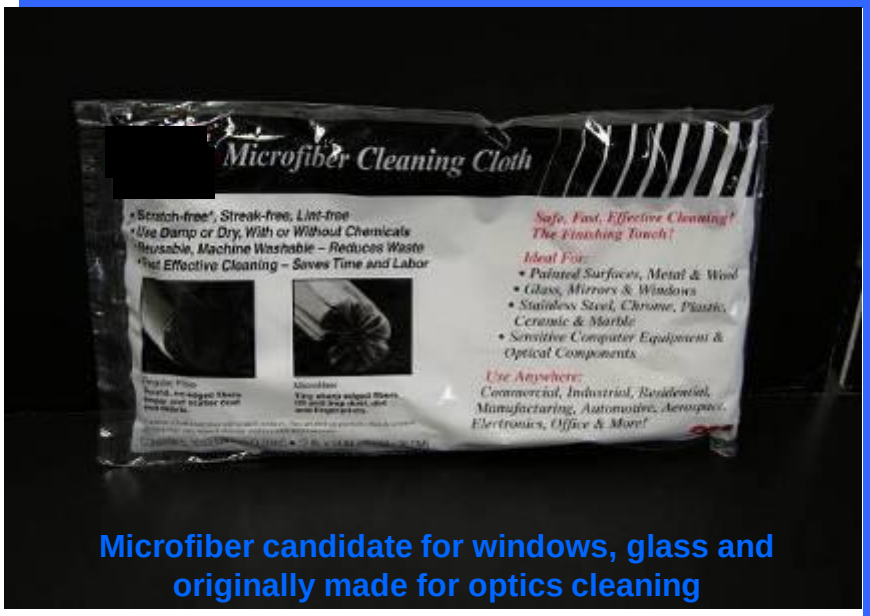
# Micro Mesh Cloths for Non Chemical Canopy and Optics Cleaning

## Description

- Evaluate the feasibility of using 3M Micro Fiber Cloth with only water for cleaning aircraft canopies , windscreens, windows, optics and instruments without the use of chemicals

## Status

- Received candidate product in house for testing
- Initial testing for haze, transmittance and clarity showed no effects on acrylic or polycarbonate materials when used with water




Microfiber candidate for windows, glass and originally made for optics cleaning

## Issues & Actions

- No issues
- Survey of areas application to be conducted during fleet visits
- Coordinating with Subsystems & internal Materials who have auspices over optical material

# Meeting the needs of the fleet
# Environmental needs

- Each of the following projects address current environmental needs
  - Comply with current legislated regulations
  - HAPS/VOC issues with paint strippers
  - Chrome VI elimination
  - HAPS compliance – fluorinated propellant.

# Evaluation & Qualification of High Rate Environmentally Compliant Chemical Paint Strippers

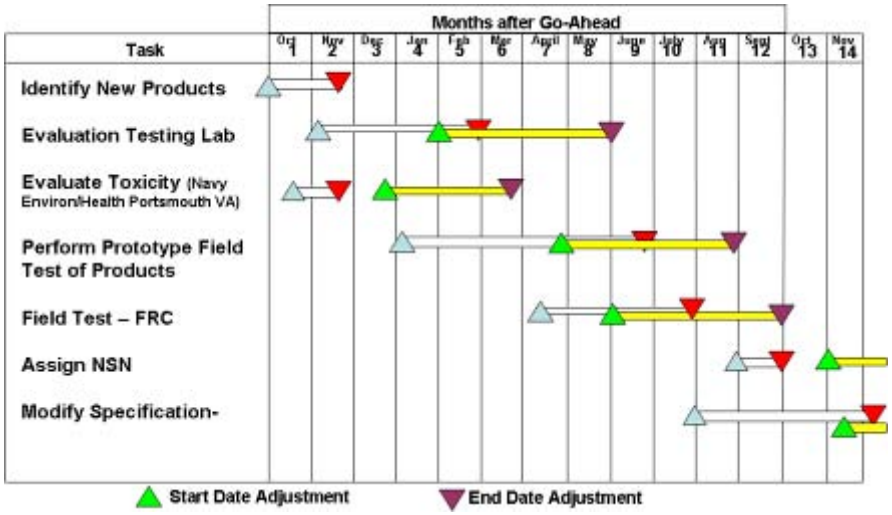
## Description

- Demonstrate and validate the performance of commercially available **peroxide-assisted benzyl alcohol chemical** paint strippers and qualify for use on aircraft substrates. If successful, output would be multiple new products qualified to **TT-R-2918** which are environmentally preferred and technically effective, and safe on metals especially high strength steels.

## Status

- Compiled candidate products for in house for testing
  - •McGean E-3000, Dekote, next two TBD.
  - •Samples ordered for E-3000 & Dekote
- Monitoring Army & SERDP R&D projects for paint removal mechanisms to see if new products evolve out of those efforts.
- Recent Fleet and FRC visits confirm need and issues.

## Schedule




## Issues & Actions

- Start and end dates were adjusted due to delay in getting TPOC on board.
  - •TPOC is on board and started work on project
- Ordering aluminum & steel test coupons
  - •Arranging for cad plating of test coupons (landing gear)
  - •Ordering primers and topcoats for panel tests.
- Reviewing toxicity of products

# Evaluation & Qualification of MIL-DTL-81706 Type II Non-Chromate Pretreatment Applicator Pen

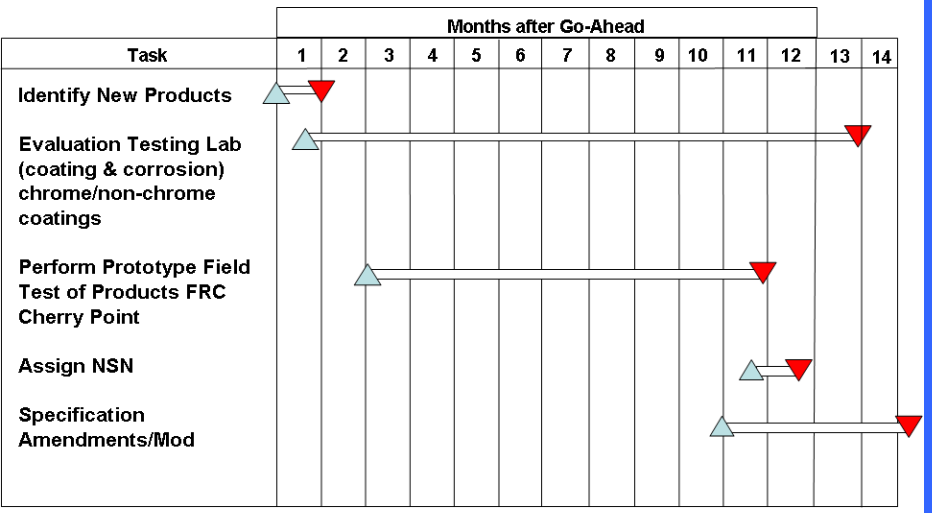
## Description

- Currently, **MIL-DTL-81706** Method D applicator pen is qualified only with hexavalent chromium, Type I, product (Alodine 1132 Touch N Prep Pen).
- Aircraft maintainers do not have environmentally friendly, non-hexavalent chromium, Type II, option.

## Status

- Received candidate touch up pens in house for testing
  - **Surtec 650, Surtec 650C pen, Henkel 817**
- Coordinating testing between Cherry Point and Pax River.
- Test panels being prepared at Pax River for testing.

## Schedule




## Issues & Actions

- No issues
- Note: Will be considered a “Weapon System Coded” item in the supply system.
- Presently coordinating testing with Materials Lab AIR 4.3 at Cherry Point, NC for field testing

# MIL-PRF-29608 Class L

NSN: /SOS: / Avtn

## Description

- Identify commercial-off-the-shelf (COTS) products formulated with a fluorinated lubricant or formulate Class L products with a fluorinated lubricant if there is no COTS product or COTS products do not meet the performance expectations
- Test in laboratories and fields
- Revise the specification and technical manuals as needed

## Status

- Miller-Stephenson MS-738 has been identified as a potential product
- Testing requirements have been identified
- Test Requirements document has been prepared
- Test panels for plastics and elastomers compatibility tests were ordered and received
- Chemicals for a new formulation were ordered and received

## Schedule (just physically mark up I will do the rest)

| Task Name | Duration | 08 | 09 | | | | 10 | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| Project Kick-off | 30 days | | | | | | | | |
| Establish testing requirements (JTP Development) | 45 days | | | | | | | | |
| COTS product identification | 30 days | | | | | | | | |
| Formulation | 30 days | | | | | | | | |
| Perform evaluation / lab tests | 360 days | | | | | | | | |
| Interim report | 90 days | | | | | | | | |
| Field tests | 270 days | | | | | | | | |
| Specification revision<br>Technical manual id / update | 180 days<br>180 days | | | | | | | | |
| Fianal & Cost and Performance Summary Reports | 60 days | | | | | | | | |

## Issues & Actions

- Formulation of a new product will be initiated in the first quarter of 2009
- Performance testing of MS-738 will be conducted in the first quarter of 2009